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PROCESS FOR IMPROVING THE COVERAGE OF RADIO CELLS IN A CELLULAR MOBILE RADIO SYSTEM AND DEVICE FOR IMPLEMENTING IT

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(57) Claim

1. Process for the improvement of radio cell coverage in a cellular mobile radio system in which a number of neighbouring and adjacent cells form a cluster, at least one fixed station is arranged at the edge region of each cell with at least one sector antenna which scans at least the region of a first cell with radio frequencies of a group of channels, characterized by the fact that fixed stations of neighbouring cells immediately adjoining said first cell and with the same group of channels as the fixed transmitter of said first cell to be served also transmit into said first cell.

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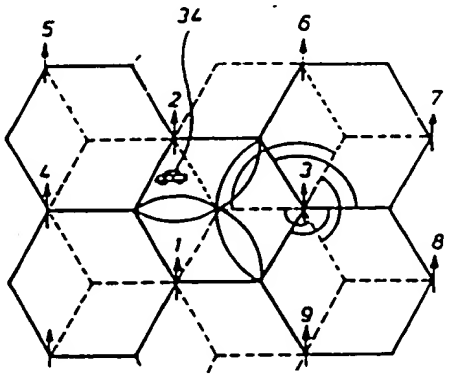
(54) Title: PROCESS FOR IMPROVING THE COVERAGE OF RADIO CELLS IN A CELLULAR MOBILE RADIO SYSTEM AND DEVICE FOR IMPLEMENTING IT

(54) Bezeichnung: VERFAHREN ZUR VERBESSERUNG DER FUNKZELLENAUSLEUCHTUNG BEI EINEM ZELLULAREN MOBILFUNKSYSTEM UND VORRICHTUNG ZUR AUSÜBUNG DES VERFAHRENS

(57) Abstract

In a process for improving radio cell coverage in a cellular mobile radio system, a number of neighbouring, bordering and partially mutually overlapping cells are provided, at least one fixed transmitter being arranged in the boundary region of each cell. In order to obtain the best possible radio cell coverage, the fixed transmitters of neighbouring and directly adjacent cells with the same channel group as the one to which the cell to be supplied belongs transmit to this cell. Thus a mobile station in the cell is served not only by one fixed transmitter but also by the fixed transmitters of neighbouring cells. To each fixed station are allocated several sector aerials which at least partly overlap in their transmitting range bounded by sectors and which together cover a range of at least 360°.



(57) Zusammenfassung

Ein Verfahren zur Verbesserung der Funkzellenausleuchtung bei einem zellularen Mobilfunksystem sieht vor, daß eine Anzahl von benachbarten, aneinander angrenzenden und gegenseitig teilweise überlappenden Zellen vorhanden sind, wobei im Randbereich jeder Zelle mindestens ein Festsender angeordnet ist. Um eine optimierte Funkzellenausleuchtung zu erhalten, ist vorgesehen, daß die Festsender benachbarter, unmittelbar an eine Zelle angrenzender Zellen mit der gleichen Kanalgruppe, wie der Festsender der zu versorgenden Zelle selbst gehört, in diese Zelle senden. Auf diese Weise wird eine in der Zelle befindliche Mobilstation nicht nur von einem Festsender versorgt, sondern auch von den Festsendern benachbarter Zellen. Jeder Feststation sind mehrere Sektorantennen zugeordnet, die sich in ihrem durch Sektoren begrenzten Sendebereich mindestens teilsweise überlappen und die zusammen mindestens einen Bereich von 360° überstreichen.

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Specification

Process for improving the coverage of radio cells in a cellular mobile radio system and device for implementing it.

Technical field

The invention relates to a process for improving the coverage of radio cells in a mobile radio system in accordance with the preamble of claim 1.

State of the art

Cellular mobile radio networks are characterized by the fact that the area to be served is divided into a number of cells, each of which is served by a fixed station. Each cell is associated with a group of channels which comprises a plurality of channels. The term "channels" is understood in the following remarks to mean speech channels, and also traffic channels (TCH) by means of which speech or data connections with mobile stations are handled. Accordingly, these are duplex radio channels for both directions of transmission, i.e. for example a pair of frequencies with a fixed duplex distance. Channels and also groups of channels may be separated by the criteria frequency, time or signal form (code), or by a combination of these criteria. It is assumed below for the decription of the process in accordance with the invention without restriction of the general validity that a group of channels consists of one or more (duplex) frequencies, while the individual channels are operated at such a frequency in a time multiple. The term "mobile station" covers all types of equipment, i.e. also portable and hand-portable subscribers' equipment.

In order to achieve as high as possible a subscriber capacity, the groups of channels should be able to be re-used as often as possible in the area for different connections, i.e. repeated in cells spatially as closely adjacent as possible (frequency repetitions or channel re-use). It must, however, be ensured that common-channel interferences, and thus reciprocal disruptions of conversations, do not occur. An arrangement of cells within

which the groups of channels associated with the cells are all different from each other and which can be repeated spatially with the same assignment of channel groups to cells without breaks in the area is known as a cluster.

A cluster arrangement of 7 consisting of hexagonal omnidirectional cells is shown in figure A. In an omnidirectional cell arrangement of this kind the omnidirectional transmitters are in each case disposed in the middle of each of the cells in question.

If a mobile station (MS) changes during a connection from one cell to an adjacent cell, a transfer procedure must be carried out by the system. It is known as "passing on" or, more frequently "hand-over" (also "hand-off" in the USA). In conventional networks in accordance with figure A such a hand-over process requires at the same time both the switching of the connection from one fixed station to another fixed station and a change from one radio channel of the present cell to that of the next cell. Undesirable multiple switchings at the cell boundaries often occur in this case, associated with the risk of the loss of the connection.

It is known that an improvement in the signal - interference ratio can be achieved with the same size of cluster, or else a reduction of the size of the cluster with the same signal - interference ratio can be achieved by the sectorization of cells, abbreviated to sector cells, with a suitable sector antenna. Fig. B and fig. C show examples of clusters with sector cells.

Fig. C shows a network with 60° sector cells. Each hexagonal cell from fig. A is divided by 60° directional antennae into 6 triangular sectors, which function as independent cells and with which their own groups of channels are in each case associated. In the hexagonal cluster of 3 shown, 18 different groups of channels are therefore produced. The advantage in comparison with fig. A lies in the better repeatability of the channels by the smaller cluster size of 3 instead of 7 with the same signal - interference ratio. This advantage, however, is in some cases cancelled by the poorer bundle yield on account of the 18 channel groups instead of 7. There is no service redundancy, i.e. each point in the area is clearly

served by only one group of channels.

Fig. B shows a hexagonal cluster of 3 with 9 diamond-shaped sector cells with 120° directional antennae. Each sector cell is, as in fig. C, associated with its own group of channels, so that 9 groups of channels are needed here in the cluster of 3. The signal - interference ratio that can be achieved is certainly poorer than in fig. C, since the main directions of radiation of cells of the same channel lie in a line, whereas in fig. C they are displaced in relation to each other. There is also no service redundancy in this network.

The arrangements of fig. A, B and C are state of the art. The corresponding clusters are accordingly known.

Outside the clusters of 10 and 13 the same arrangements are repeated with homogeneous field strength distributions, the fixed stations 1-9 transmitting in such a way that interferences (amplification and initiation of amplitudes of the same wavelength) are avoided.

Associated with the arrangement of such clusters of 10 and 13, however, is the disadvantage that only a small number of channel groups can be made available, which restricts the capacity of a large number of mobile stations in the sector cells in question to be actuated.

A further disadvantage of the known cluster concept with sector cells and sector antennae disposed in the edge region of the sector cells is the fact that only an inadequate coverage of the sector cell in question is given by the fixed station located in the marginal region. The farther the mobile station moves from the fixed station, the poorer becomes the quality of reception, which, in addition, is adversely affected by interferences from fixed stations of adjacent cells.

In addition, the so-called hand-over procedure is made difficult in the known cells in accordance with fig. B, since with the only inadequate coverage of the sector cells by fixed stations located in the marginal region severe variations may occur in the reception field strength in the mobile station, without this already being handed over to the fixed station

of the adjacent sector cell. Hence the known hand-over procedure is relatively unreliable and time-critical.

Representation of the invention

The invention is therefore based on the problem of developing a process of the aforementioned type in such a way that an improved radio cell coverage can be achieved with a simplified and interference-free hand-over process.

For the solution of the problem posed the invention is characterized by the technical theory of claim 1.

A characteristic feature of the invention is the fact that a single fixed station is now no longer associated with a cell, but that the fixed stations of adjacent cells which adjoin the aforementioned cell also transmit into the region of the aforementioned cell with the same group of channels.

Through this it is ensured that each mobile station which is located in a cell is served not only by the one fixed station located in the sector cell itself, but also by the fixed stations of adjoining cells.

No longer is one 120° sector antenna associated with each fixed station, but now there are 6, the radiation ranges of which overlap by 60°. Its own group of channels is assigned to each of the 6 sectors of a fixed station. Sectors of adjoining fixed stations facing each other have the same group of channels and are synchronized with each other. Each mobile station is in principle always newly served by the three nearest fixed stations. Each channel in each fixed station is provided with an individual power assignment, the power of a fixed station on this channel being in each case proportional to its contribution at the receiver input of the mobile station, with the additional limit condition that the total power at the receiver input is just above the minium tolerable signal - interference interval for a given transfer quality under fading conditions (adaptive power assignment). The transmissions of each fixed station on each channel are predistorted in accordance with a separate object of the

invention in such a way that the transfer path to the mobile station acts as a distortion correction means. Thus the contribution of each fixed station at the point of reception is optimally corrected and the individual contributions are isochronously superimposed. The transmissions of each mobile station are basically received in the three nearest fixed stations and then passed to diversity combining.

This means that a decision is made between the fixed stations transmitting on the same group of channels as to which fixed station may transmit to the cell to be covered and with what transmission power.

If the vehicle is now, for example, in the middle range between two fixed stations, but far from the third fixed station, the power of the individual fixed stations is then regulated so that the two fixed stations lying nearest to the vehicle transmit with part of their power in each case, while the third fixed station is shut off.

There is therefore the considerable advantage that an optimal radio cell coverage of the cell in question occurs, since the cell is covered from several sides, which was hitherto not possible.

The mobile stations are power-regulated, with regulation from the fixed side in order here also to observe the condition for the minimum tolerable signal - interference ratio. The parameters for power regulation can be calculated sufficiently accurately from the reception power in each case.

Altogether, with this network configuration a cell pattern, again with abstracted hexagonal cells which are interspersed and with each of which is associated its own group of channels, is produced.

The cells are covered from three of the six corners in each case by fixed stations and overlap each other to the extent of one-third. In this way each such cell is finally covered by two groups of channels.

In a network of this kind there are two forms of hand-over. Firstly, an implied or "soft" hand-over which is produced by the adaptive power

allocation on the fixed side and which the mobile station does not recognize. It is brought about through the flowing transition between the 3 fixed stations which serve a cell with the same group of channels. At least one or two of the fixed stations remain still participating in the connection. A change of channels does not take place.

Secondly, a conventional hand-over with change of channel in the overlapping region between two cells, which thus always occurs in regions which as a rule are equally well served by two fixed stations, both on the old and the new channel and which do not coincide with sector boundaries or conventional radio zone boundaries. This hand-over is therefore neither unreliable nor time-critical.

The power regulation of the fixed stations is determined by means of a mathematical algorithm.

Advantages:

- clusters of 3 are produced with a considerable gain in frequency economy;

- the hand-over procedures take place "unnoted" and completely without problems;

- the quality of the service in accordance with the proposal is much higher than in networks of the prior art.

The object of the present invention is seen not only from the objects of the individual claims, but also from a combination of the individual claims. All data and characteristics disclosed in the documents, including the abstract, and in particular the spatial design shown in the drawings, are claimed as essential to the invention, inasmuch as they are new in relation to the state of the art, either individually or in combination.

Brief description of the drawings

The invention is explained in greater detail below by means of drawings showing only one embodiment. Here further characteristics

essential to the invention and advantages of the invention can be seen from the drawings and the description of them.

The drawings show:

figure A: omnidirectional cells in accordance with the state of the art;

figure B: sector cell with 120° sectors in accordance with the state of the art;

figure C: triangular cells with 60° sectors in accordance with the state of the art;

figure 1: a hexagonal cell pattern with edge coverage in accordance with the invention;

figure 2: the middle cell as in figure 1 on a larger scale with further details;

figure 3: network in accordance with the invention with 120° sector antennae and hexagonal cells with edge coverage and multiple overlapping in accordance with the invention;

figure 4: hand-over with channel change in the region of overlap of two cells in accordance with the invention;

figure 5: grouping of the antennae with six groups of channels in the case of a cluster of 3 in accordance with the invention.

Figures A, B and C were already described in the introduction to the specification as cluster concepts belonging to the state of the art. According to figure B, it is known, for example, that the fixed stations 1, 2, 3, 4 shown there radiate the sector cells 20 to 23 with a single sector antenna and with an angle of 120°, which suffers from the disadvantage that the farther the vehicle in the sector cell 20-23 in question moves from the associated fixed station 1-4, the poorer the reception quality becomes.

The closer the vehicle approaches to another fixed station in an adjacent sector cell, the greater the danger then is that interferences will occur between the channel group in one sector cell (e.g. the sector cell 20) and the same group of channels in a sector cell of an adjacent cluster (e.g. the sector cell 20a).

A new cell concept as shown in figure 1 is proposed in accordance with the invention, which operates, for example, with six antennae overlapping by 60° in each case, the antenna beams of the antennae associated with each fixed station 1, 2, 3 being shown only schematically in figure 1.

Figure 1 is intended to show that if a mobile station is located, for example, in the cell 20, this mobile station (vehicle 34, figure 3) is served not only by the fixed station 1 directly associated with the cell 20, but in addition by the fixed station 2 and, thirdly, also by the fixed station 3.

This concept applies in a similar manner to all adjacent cells 22, 24, 25, 26.

Embodiment of the invention

The example schematized in figure 1 will be explained in greater detail by figures 2 and 3 by means of an embodiment with sector antennae which radiate with a sector angle 12 of 120°.

Here it is assumed for the sake of diagrammatic simplification that six antennae A, B, C, D, E, F are present and that each of the antennae A -F scans a sector angle a-a or b-b or c-c and so on to f-f.

The fixed station 1 associated with the cell 20 accordingly has six antennae which transmit with uniform distribution along the periphery of a circle and consequently transmit not only into the cell 20, but in the same way into the adjacent cells 25 and 26. In addition, it serves three further cells, the hexagonal boundaries of which are shown with broken lines in figure 3, and two of which each overlap to one-third the middle cell 20.

The same applies to the fixed station 2 with its sector antennae, which also radiate not only into their own cell 21, but also into the cell 20 and the adjacent cell 22. This fixed station 2 serves in addition three further overlapping cells. This applies in a similar manner to the fixed station 3.

From this, with reference to the cell 20 to be considered, it can be seen that a vehicle 34 located in the cell 20 is served by three different fixed stations 1-3 with transmission energy.

Through this, using six groups of channels, two interlaced and overlapping clusters of 3 are formed which are displaced in relation to each other by one cell radius, as shown in figure 3. It must be pointed out here that the network in accordance with the invention has the same number of fixed stations as the known arrangements of figures A, B and C, and thus manages without any increase in the number of positions.

The number of possible frequencies is now obtained by the overlapping of the antennae A-F which has been described. Each antenna A-F transmits with a sector angle 27-32, which is shown in the embodiment as 120°. In another embodiment of the invention this sector angle may also be 90° (with a reciprocal overlapping of 45°) or also 60° (with a reciprocal overlapping of 30°).

It is shown with respect to the fixed station 1 in the example of figure 2 that the antenna A, for example, overlaps with the antenna F in the overlapping region 37.

An overlapping is possible because the antenna A transmits with a different frequency from that at which, for example, the antenna B or the antenna F transmits. Because of this the number of possible conversations in the region of the cell 20 is greatly increased, since there are available, for example, 16 speech channels both with one group of channels and with the other group of channels, which also transmits into the cell 20.

It goes without saying that the same conditions must also exist for

the other sector antennae of the fixed stations 2, 3. That is, related to the fixed stations 2, the antennae C overlap with B and C with D with regard to the cell 20 and it is clear that these antennae transmit in each case in the same group of channels as the antennae previously described in the example of the fixed station 1, in order to serve a vehicle located in the region of the cell 20 uniformly with the transmission frequency produced at the time.

The same explanations also apply to the sector antennae of the fixed station 3.

A so-called hand-over procedure on passing from a cell 20 to an adjacent overlapping cell will be explained by means of figure 4.

It is assumed here that the vehicle 34 is located approximately in the middle region between the two fixed stations 1, 2 and is farthest from the fixed station 3. An arrangement is now made between the aforementioned fixed stations 1, 2, 3 with the purpose of establishing which of the fixed stations has power enough to communicate with the mobile station (vehicle 34). Since the vehicle 34 receives the transmission beams 18, 19 of the two fixed stations 1, 2 the most strongly and the transmission beam 36 from the fixed station 3 only weakly, the fixed station 3 is switched off, while the other two fixed stations 1, 2 transmit with about $^1/_3$ of their available power in each case. A power which would be sufficient to serve the entire region of the cell 20 with a single fixed station, possibly with a central arrangement as in figure A, is here defined as "available power".

The passing-on of a connection from one fixed station to another by radio channel is brought about in the process in accordance with the invention by the adaptive power association described above without the necessity of making a change in the radio channel. The power association is determined by mathematical algorithm.

If the mobile station (vehicle 34) moves from one cell into an adjacent overlapping cell, a hand-over with a change of channel is effected. The cell 20 served by the fixed stations 1, 2 is delimited laterally by the edges 16 and 17, while the edges 14 and 15 of the adjacent

overlapping cell, which is served by the fixed stations 1, 2 and 4, extend into the cell 20.

In the transitional region between these two cells a transfer zone 33 is thus produced, which, on account of the transmission beams 18, 19 of the fixed stations 1, 2, is roughly elliptical in shape. The vehicle 34 moves in the direction of the arrow 35 out of the cell 20 in the direction of the fixed station 4.

This movement is determined by the control between the individual fixed stations 1, 2, 3 and the transmission beam 36 of the fixed station 3 is interrupted, the mobile station 34 being served to approximately equal extents only by the fixed stations 1, 2.

In this elongated elliptical region a hand-over with a change of the radio channel can now be made. It thus always takes place in regions which, as a rule, are served equally well by two fixed stations, on both the old and the new channels, and which do not coincide with sector boundaries or conventional cell boundaries. This hand-over procedure in accordance with the invention is, in contrast to previous networks, reliable, it is not time-critical and is not bound to precise places. In this way undesirable multiple switchings can also be avoided. The procedure described obviously applies in the same way for any directions of movement of a mobile station and the transfer of it into another adjacent overlapping cell.

In addition to the reliability of this procedure, it can be mentioned as a further advantage that the boundaries within which the group of channels of a cell is actually used can be reduced to the sectorially roughly elliptical outer hand-over boundaries between two fixed stations, as shown in figure 4 between the fixed stations 1 and 2. Through this the signal - interference ratios in the network are still further improved.

Finally, figure 5 shows the allocation of the six channels 1 to 6 necessary for a cluster of 3 to the 120° sector antennae of the fixed stations FS1 to FS3 in such a cluster of 3 as can be extended over an area. Here the FS1' have the same antenna coverage as FS1. This applies accordingly to FS2' and FS3'.

Commercial applicability

Finally, mention can be made of the following important advantages of a network in accordance with one or more claims of the invention.

- improvement in service reliability through multiple coverage

- reduction of the transmission power of fixed stations and mobile stations by transmitter and receiver diversity on the fixed side

- improvement in signal-interference ratios in the network which can be converted into a reduction in the common channel repeat interval

- reliable hand-over procedure, not critical with respect to time or place, without the risk of loss of existing connections

- better load capacity of the channels (bundle gain) because of the smaller number of groups of channels, i.e. more channels per channel group, and by service redundancy.

These characteristics lead to a considerable increase in frequency economy, i.e. the number of subscribers that can be served in a restricted available frequency band, and an improvement in the quality of service offered to subscribers by improved delivery and reliable hand-over procedures without resulting in an increase in the number of fixed stations.

Diagram legends

1. fixed station
2. "
3. "
4. "
5. "
6. "
7. "
8. "
9. "
10. cluster
12. sector angle
13. cluster
14. edge
15. edge
16. edge
17. edge
18. transmission beam
19. transmission beam
20. cell
20a. common-channel cell
21. cell
22. cell
23. cell
24. cell
25. cell
26. cell
27. sector angle antenna A
28. sector angle antenna B
29. sector angle antenna C
30. sector angle antenna D
31. sector angle antenna E
31 (sic) sector angle antenna F
33. transfer zone
34. vehicle (mobile station)
35. direction of arrow
36. transmission beam
37. overlap region
38. overlap region

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Process for the improvement of radio cell coverage in a cellular mobile radio system in which a number of neighbouring and adjacent cells form a cluster, at least one fixed station is arranged at the edge region of each cell with at least one sector antenna which scans at least the region of a first cell with radio frequencies of a group of channels, characterized by the fact that fixed stations of neighbouring cells immediately adjoining said first cell and with the same group of channels as the fixed transmitter of said first cell to be served also transmit into said first cell.

2. Process in accordance with claim 1, characterized by the fact that the fixed stations are synchronized with each other.

3. Process in accordance with one of claims 1 or 2, characterized by the fact that each mobile station which is located in a cell is served simultaneously by a maximum of three different fixed stations.

4. Process in accordance with any one of claims 1 to 3, characterized by the fact that each channel in each fixed station transmits with a power that can be regulated, the power of a fixed station on each channel being in each case set proportionally to the contribution of the transmission power of each fixed station at the receiver input of the mobile station.

5. Process in accordance with any one of claims 1 to 3, characterized by the fact that each channel in each fixed station transmits with an individual regulatable power, the power of a fixed station being in each case set proportionally to the received power of the mobile station at the receiver input of each fixed station.

6. Process in accordance with claim 4, characterized by the fact that the transmission power of the fixed stations is set so that the total power of them at

the receiver input of the mobile station lies just above the minimum tolerable signal to interference ratio for a specific transfer quality with fading.

7. Process in accordance with any one of claims 1 to 6, characterized by the fact that the transmissions of a mobile station are received by the fixed station of the cell in which the mobile station is located and by the fixed stations of the adjoining cells and that an equalization of the transmission powers between these fixed stations takes place in such a way that the fixed stations which are nearest to the mobile station transmit with part of their power, while the fixed stations that are at a distance from the mobile station, transmit with a smaller fraction of their power or are completely switched off.

8. Process in accordance with any one of claims 1 to 6, characterized by the fact that the transmissions of a mobile station are received by the fixed station of the cell in which the mobile station is located and by the fixed stations of the adjacent cells and that these received signals are subjected to diversity combining in order to improve the quality of them.

9. Process in accordance with any one of claims 1 to 8, characterized by the fact that the transfer (hand-over) procedure of a mobile station in the connected state from one sector of a cell to an adjacent sector of said cell is achieved by an adaptive power allocation of the fixed stations which cover the cell.

10. Process in accordance with any one of claims 1 to 9, characterized by the fact that the transfer (hand-over) procedure of a mobile station in the connected state from one cell to an adjacent cell is effected by a change of channel such that at least one of the fixed stations participates in the connection both before and after the transfer procedure.

11. Device for radio cell coverage in a cellular mobile radio system, comprising one or more cells forming in each case a cluster in which at least one fixed station is disposed in the edge region of each cell, said station having

at least one sector antenna which covers the region of a first cell with a group of channels, characterized by the fact that a plurality of sector antennae which overlap at least partially in their transmission range delimited by sectors and which together cover a range of 360° is associated with each fixed station.

12. Device in accordance with claim 11, characterized by the fact that a total of six sector antennae, each with a sector angle of 120° are associated with the fixed station and that the transmission ranges of the sector antennae overlap by 60°.

13. Device in accordance with claim 11, characterized by the fact that eight sector antennae, each with a sector angle of 90°, are associated with the fixed station and that the transmission ranges of the sector antennae overlap by 45° in each case.

14. Device in accordance with claim 11, characterized by the fact that a total of twelve sector antennae, each with a sector angle of 60°, are associated with the fixed station and that the transmission ranges of the sector antennae overlap by 30° in each case.

15. Device in accordance with any one of claims 11 to 14, characterized by the fact that the transmission power of each channel in each fixed station can be regulated according to the power received by the mobile station at the receiver input of each fixed station and is adjusted in relation to the transmission power of each mobile station.

16. Device in accordance with any one of claims 11 to 15, characterized by the fact that each fixed station transmits with only a fraction of the power that would be necessary to serve the entire cell with transmission power.

DATED this 12th day of December, 1995.

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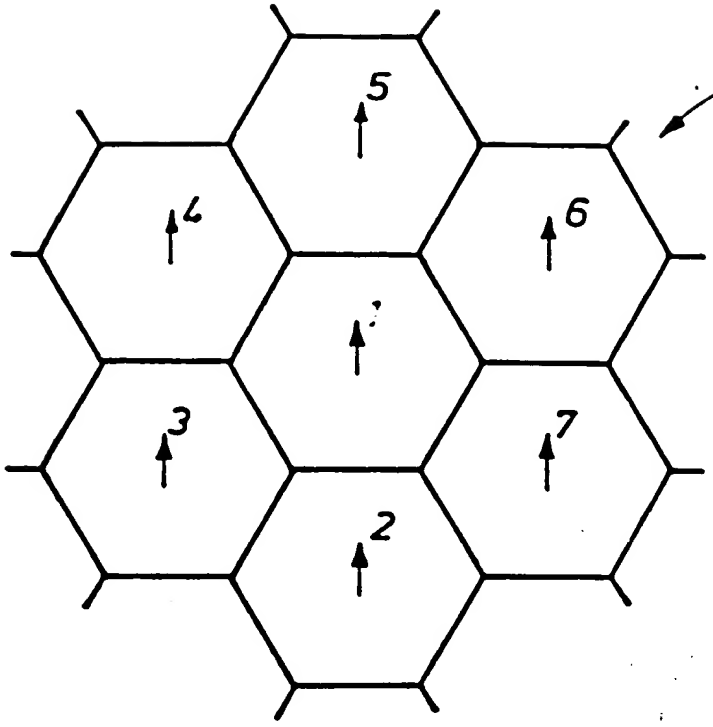


FIG A

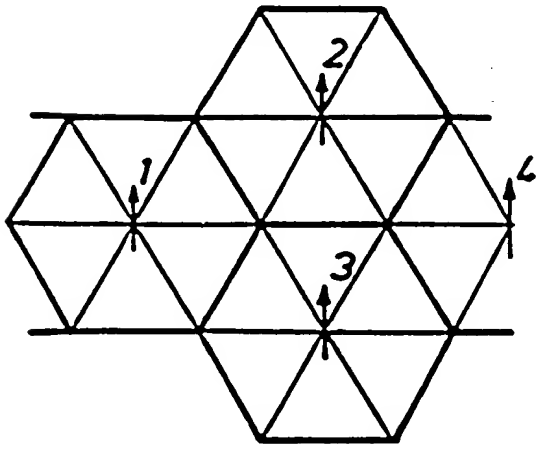


FIG C

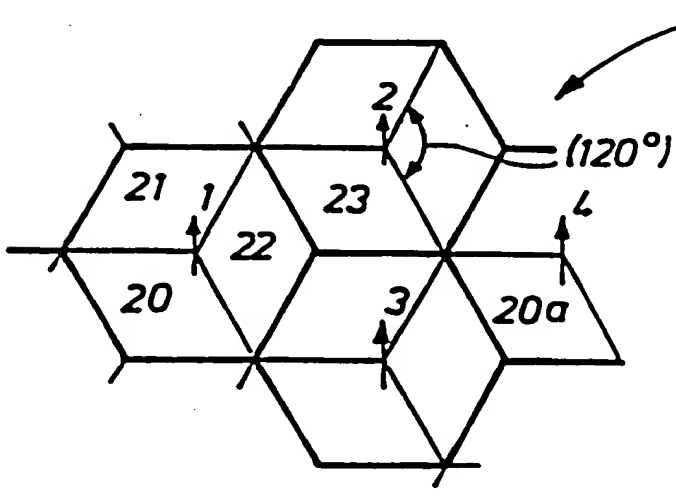


FIG B

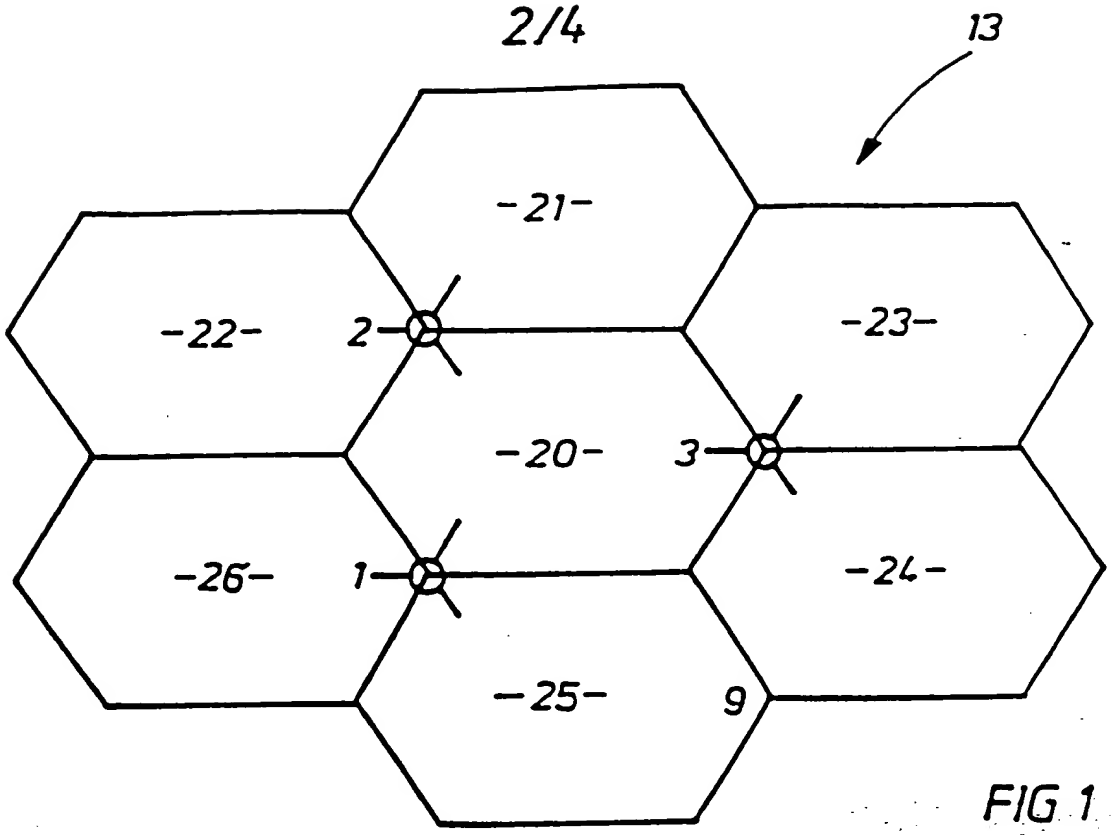
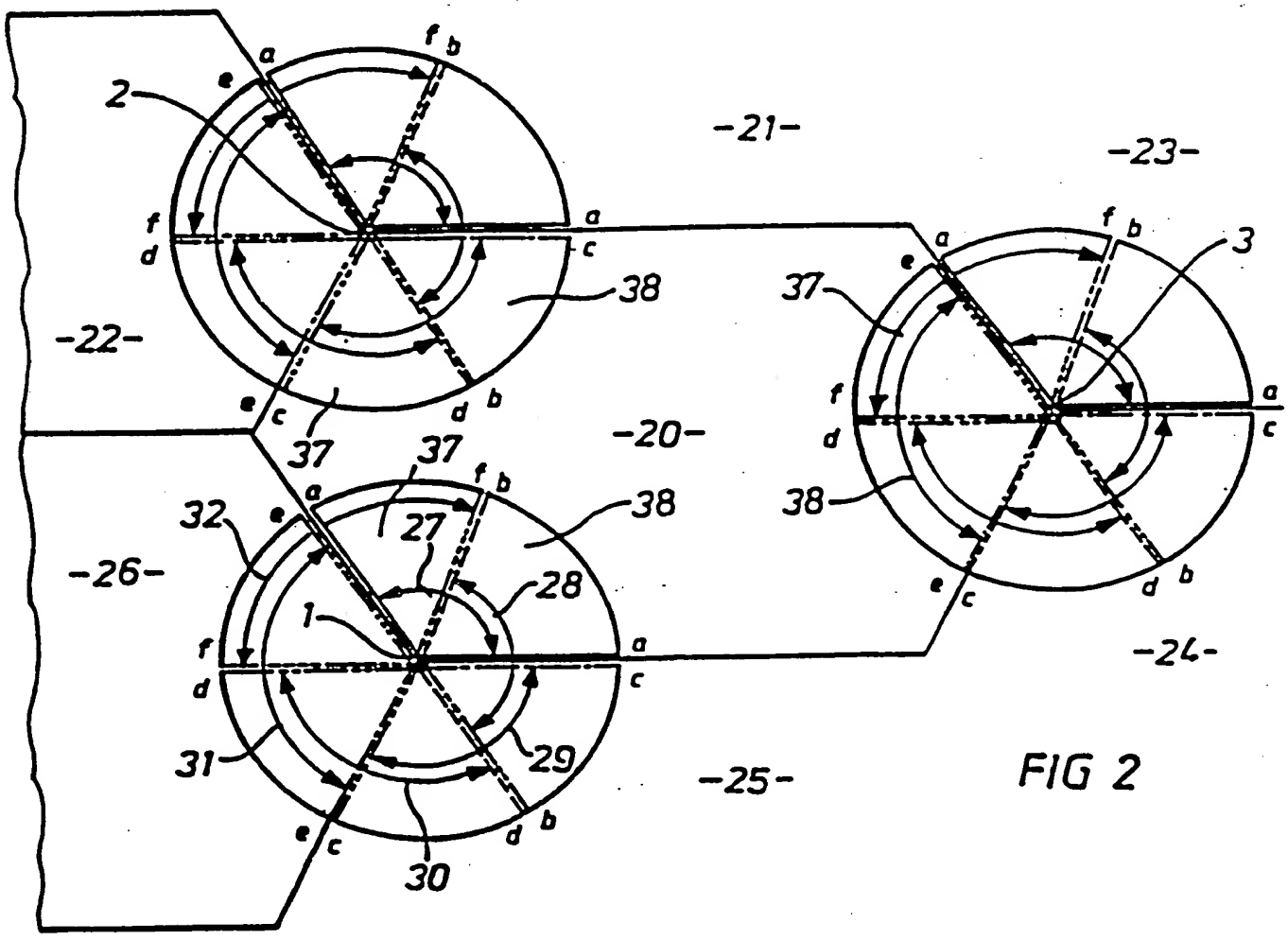

13
-21-
-22-
2
-23-
-20-
3
-26-
1
-24-
-25-
9

FIG 1


-21-
-23-
-22-
-20-
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38
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28
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31
32
a
b
c
d
e
f

FIG 2

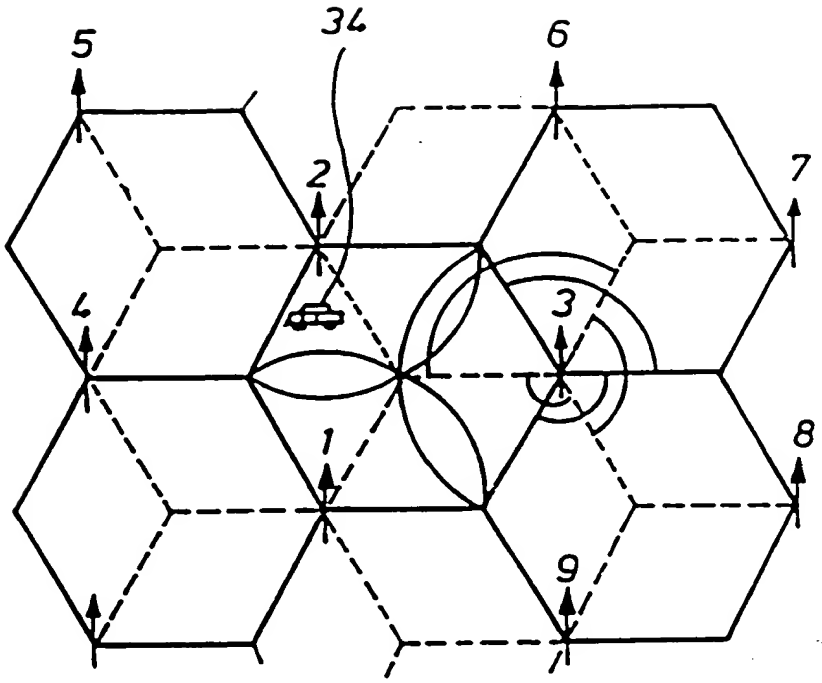

FIG 3

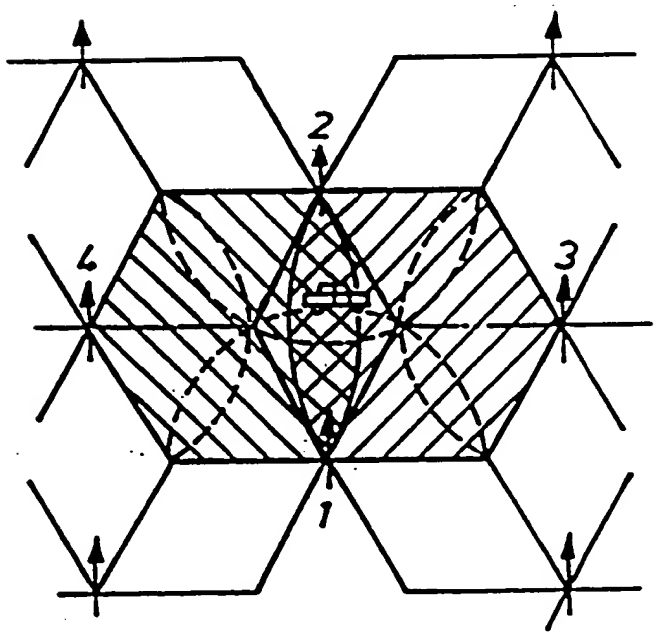

FIG 4

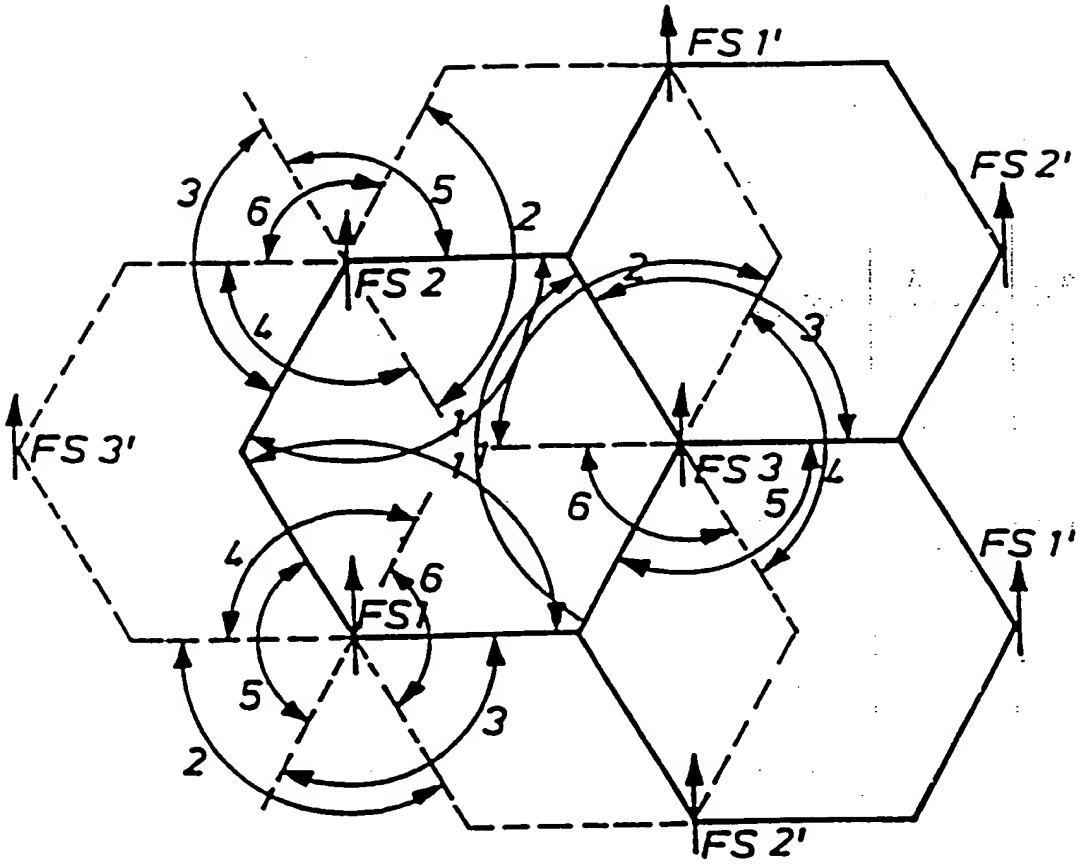

FIG 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DE 92/00994

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.[5] H04B7/26; H04Q7/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl.[5] H04Q ; H04B ; H04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,9 107 043 (PACTEL CORP.) 16 May 1991 see page 5, line 6 - page 6, line 12	1-3,5, 7-9,11 15,16
A	see page 6, line 34 - page 8, line 30 see page 10, line 7 - line 16 see page 10, line 26 - page 12, line 10 see page 12, line 28 - page 13, line 25 see page 14, line 4 - page 15, line 7 see page 18, line 5 - line 22	2,4,6,10
X	FR,A,2 438 389 (CIT-ALCATEL) 30 April 1980	1
A	see page 2, line 12 - line 37	11

./.

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 February 1993 (18.02.93)	26 February 1993 (26.02.93)
Name and mailing address of the ISA EUROPEAN PATENT OFFICE Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB,A,2 242 805 (STC PLC) 9 October 1991 see page 2, line 1 - line 20 see page 2, line 35 - page 5, line 1	1,10
A	39TH IEEE VEHICULAR TECHNOLOGY CONFERENCE 1 May 1989, SAN-FRANCISCO (US) pages 625 - 603 , XP292054 V. PALESTINI 'EVALUATION OF OVERALL OUTAGE PROBABILITY IN CELLULAR SYSTEMS' see page 626, paragraph 3 - page 627, paragraph 4	1,3-6
A	IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS 19 June 1983, BOSTON (US) pages 554 - 558 C-E. SUNDBERG 'Novel Antenna Configurations for Cellular Digital Mobile Radio Systems' see page 555, left-hand column, paragraph 3 - right-hand column, line 10	1,11,12, 14

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

DE 9200994
SA 67151

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 18/02/93

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
WO-A-9107043	16-05-91	EP-A-	0502019	09-09-92
		JP-T-	4507177	10-12-92
		US-A-	5067147	19-11-91
FR-A-2438389	30-04-80	None		
GB-A-2242805	09-10-91	DE-A-	4101909	17-10-91
		FR-A-	2660816	11-10-91

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen PCT/DE 92/00994

I. KLASSIFIKATION DES ANMELDUNGSGEGENSTANDS (bei mehreren Klassifikationssymbolen sind alle anzugeben)*

Nach der Internationalen Patentklassifikation (IPC) oder nach der nationalen Klassifikation und der IPC

Int.Kl. 5 H04B7/26; H04Q7/04

II. RECHERCHIERTE SACHGEBIETE

Recherchierter Mindestprüfstoff [7]

Klassifikationssytem	Klassifikationssymbole
Int.Kl. 5	H04Q ; H04B ; H04H

Recherchierte nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Sachgebiete fallen [8]

III. EINSCHLAGIGE VEROFFENTLICHUNGEN [9]

Art.*	Kennzeichnung der Veröffentlichung [11], soweit erforderlich unter Angabe der maßgeblichen Teile [12]	Betr. Anspruch Nr. [13]
A	WO,A,9 107 043 (PACTEL CORP.) 16. Mai 1991 siehe Seite 5, Zeile 6 - Seite 6, Zeile 12 siehe Seite 6, Zeile 34 - Seite 8, Zeile 30 siehe Seite 10, Zeile 7 - Zeile 16 siehe Seite 10, Zeile 26 - Seite 12, Zeile 10 siehe Seite 12, Zeile 28 - Seite 13, Zeile 25 siehe Seite 14, Zeile 4 - Seite 15, Zeile 7 siehe Seite 18, Zeile 5 - Zeile 22 ---	1,3,5, 7-9,11, 15,16 2,4,6,10
X	FR,A,2 438 389 (CIT-ALCATEL) 30. April 1980	1
A	siehe Seite 2, Zeile 12 - Zeile 37 ---	11

-/--

* Besondere Kategorien von angegebenen Veröffentlichungen [10]:

"A" Veröffentlichung, die den allgemeinen Stand der Technik definiert, aber nicht als besonders bedeutsam anzusehen ist

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"O" Veröffentlichung, die sich auf eine mündliche Offenbarung, eine Benutzung, eine Ausstellung oder andere Maßnahmen bezieht

"P" Veröffentlichung, die vor dem internationalen Anmeldedatum, aber nach dem beanspruchten Prioritätsdatum veröffentlicht worden ist

"T" Spätere Veröffentlichung, die nach dem internationalen Anmeldedatum oder dem Prioritätsdatum veröffentlicht worden ist und mit der Anmeldung nicht kollidiert, sondern nur zum Verständnis des der Erfindung zugrundeliegenden Prinzips oder der ihr zugrundeliegenden Theorie angegeben ist

"X" Veröffentlichung von besonderer Bedeutung; die beanspruchte Erfindung kann nicht als neu oder auf erfinderischer Tätigkeit beruhend betrachtet werden

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"&" Veröffentlichung, die Mitglied derselben Patentfamilie ist

IV. BESCHEINIGUNG

Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
18.FEBRUAR 1993	26.02.93
Internationale Recherchenbehörde	**Unterschrift des bevollmächtigten Bediensteten**
EUROPAISCHES PATENTAMT	GERLING J.C.J.

Formblatt PCT/ISA/210 (Blatt 2) (Januar 1985)

III. EINSCHLAGIGE VEROFFENTLICHUNG (Fortsetzung von Blatt 2)

Art °	Kennzeichnung der Veröffentlichung, soweit erforderlich unter Angabe der maßgeblichen Teile	Betr. Anspruch Nr.
A	GB,A,2 242 805 (STC PLC) 9. Oktober 1991 siehe Seite 2, Zeile 1 - Zeile 20 siehe Seite 2, Zeile 35 - Seite 5, Zeile 1 ---	1,10
A	39TH IEEE VEHICULAR TECHNOLOGY CONFERENCE 1. Mai 1989, SAN-FRANCISCO (US) Seiten 625 - 603 , XP292054 V. PALESTINI 'EVALUATION OF OVERALL OUTAGE PROBABILITY IN CELLULAR SYSTEMS' siehe Seite 626, Absatz 3 - Seite 627, Absatz 4 ---	1,3-6
A	IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS 19. Juni 1983, BOSTON (US) Seiten 554 - 558 C-E. SUNDBERG 'Novel Antenna Configurations for Cellular Digital Mobile Radio Systems' siehe Seite 555, linke Spalte, Absatz 3 - rechte Spalte, Zeile 10 -----	1,11,12, 14

ANHANG ZUM INTERNATIONALEN RECHERCHENBERICHT
ÜBER DIE INTERNATIONALE PATENTANMELDUNG NR.

DE 9200994
SA 67151

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten internationalen Recherchenbericht angeführten Patentdokumente angegeben.
Die Angaben über die Familienmitglieder entsprechen dem Stand der Datei des Europäischen Patentamts am
Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

18/02/93

Im Recherchenbericht angeführtes Patentdokument	Datum der Veröffentlichung	Mitglied(er) der Patentfamilie		Datum der Veröffentlichung
WO-A-9107043	16-05-91	EP-A-	0502019	09-09-92
		JP-T-	4507177	10-12-92
		US-A-	5067147	19-11-91
FR-A-2438389	30-04-80	Keine		
GB-A-2242805	09-10-91	DE-A-	4101909	17-10-91
		FR-A-	2660816	11-10-91

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